PEACE/WILLISTON
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PROGRAM

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Williston Reservoir Stocked Kokanee Spawning Assessment, 1994

A. R. Langston and R. J. Zemlak
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The Peace/Williston Fish & Wildlife Compensation Program is a cooperative venture of BC Hydro and the provincial fish and wildlife management agencies, supported by funding from BC Hydro. The Program was established to enhance and protect fish and wildlife resources affected by the construction of the W.A.C. Bennett and Peace Canyon dams on the Peace River, and the subsequent creation of the Williston and Dinosaur Reservoirs.

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Website: *www.bchydro.bc.ca/environment/initiatives/pwcp/*

This report has been approved by the Peace/Williston Fish and Wildlife Compensation Program Fish Technical Committee.

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ABSTRACT

An assessment of the Williston Reservoir kokanee stocking program was undertaken in 1994, by enumerating spawning kokanee in four streams. The stocked streams studied were Carbon Creek, Dunlevy Creek, Manson River, and Nation River. The timing of the spawning run, and exact spawning locations of the kokanee were unknown prior to the initiation of this study. Survey techniques included aerial reconnaissance, gill netting, and ground surveys of stocked streams. Spawning condition kokanee were observed in Dunlevy Creek (300 - 400) and in a Nation River tributary (2,000 estimated). Adult kokanee in spawning condition were captured by gill nets in the embayments of Carbon (n=81) and Dunlevy (n=23) Creeks. A kokanee sport fishery in the embayment areas of Carbon and Dunlevy Creeks appears to have been created. Only six kokanee were observed in Carbon Creek. Kokanee were not observed in Manson River. A comprehensive assessment of the kokanee stocking program could not be arrived at with the results of this study. The limited data accumulated on the timing of the spawning run indicates late September as the peak spawning period. Future assessments of the kokanee stocking program will require further investigations concentrating at the locations, and time periods identified in this report.

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INTRODUCTION

The Peace/Williston Fish & Wildlife Compensation Program began a kokanee stocking program for Williston Reservoir in 1990. The intent of the stocking program was to create a new self sustaining kokanee population and to improve the existing fishery (Blackman et al. 1990). The purpose of this study is to assess the kokanee stocking program of Williston Reservoir.

Kokanee from the Hill Creek Spawning Channel facility (Arrow Lakes Stock) provided the donor source of fish for stocking. The kokanee were reared over winter at the Loon Creek Fish Hatchery and released the following year into four tributary streams of Williston Reservoir. The four tributary streams stocked are Carbon and Dunlevy creeks, and Manson and Nation rivers (Fig. 1). The number of fish stocked, in each system, ranged from 25,000 to 206,198 (Appendix 1).

The first spawning kokanee were expected to return to their stocked streams in the fall of 1993. The brood source for the stocked Williston kokanee (Hill Creek stock) reach their peak spawning period in mid-September (Hill Creek Spawning Channel records). Aerial surveys and ground surveys were conducted from early September to early November, 1993. No kokanee were located in the four stocked streams. The reason why no fish were found is not known. It can not be assumed that the stocking program failed in that particular year, only that the field investigations failed to locate any spawning kokanee.

A wild stock population of kokanee, which spawns in the Finlay River, is present in Williston Reservoir (Blackman 1992). This population is believed to be spawning from late November to as late as January (Fielden 1991, 1992). This stock may have originated from Skeena sockeye stocks since the Finlay River headwaters of Thutade Lake does contain kokanee. Aerial surveys conducted on twenty Williston Reservoir streams in 1990 located kokanee only in the Finlay River (McLean and Blackman 1991). A wild stock population of kokanee is also present in small numbers in a few isolated locations of the Parsnip drainage (Crooked and Parsnip Rivers). Angler reports indicate kokanee presence in Tacheeda Lakes, and a kokanee was captured in Davie Lake during a Fisheries Branch study (Coombes 1985). The origin of these kokanee is likely the Fraser River since Arctic Lake contains a kokanee population (Nelson 1968). The timing of spawning and size of this population is unknown. No sizeable spawning runs have been noted.

Evaluating the stocking program requires analysis of a number of factors. Determination of total escapement, fecundity, male/female ratio, and successful egg deposition are essential to assess the success of the stocking program. Elements more applicable to the management of the kokanee stocks (age at return, size at return) were also examined; however, the focus of this study is directed to the actual success of the stocking program in terms of how many returned, and whether a self sustaining population will result.

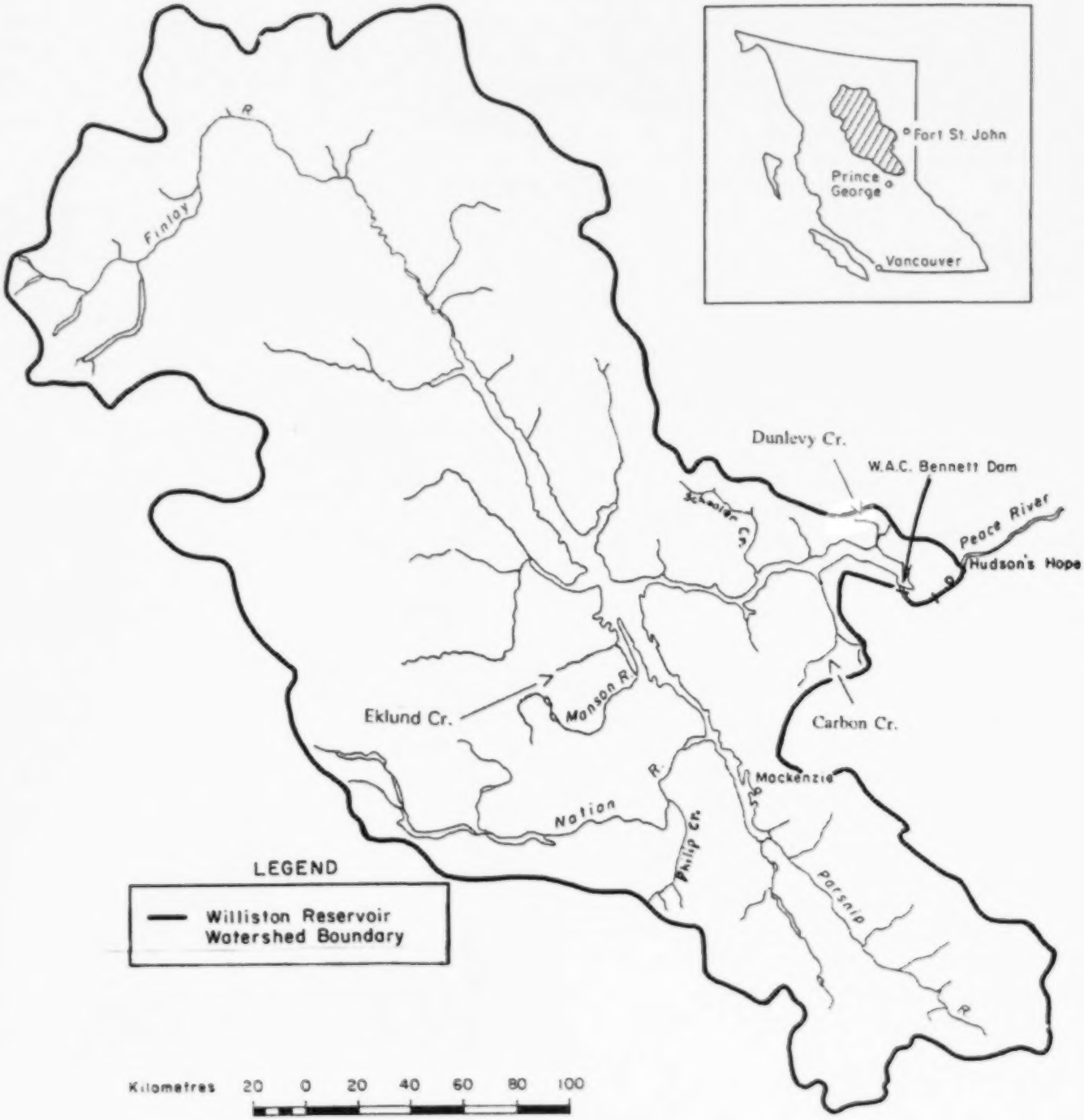

Figure 1. Williston Reservoir and surveyed tributaries.

METHODS

Study Area

The Williston Watershed is located in north central British Columbia occupying an area of 70,860 square km. The watershed is roughly oval shaped, 275 km in width and 525 km in length, with it's southern boundary 40 km north of Prince George (Fig. 1). Specific streams surveyed include:

1. Carbon Creek flows north through the Rocky Mountain Foothills into the east end (Peace Reach) of Williston Reservoir.
2. Dunlevy Creek flows south through the Rocky Mountain Foothills into the east end (Peace Reach) of Williston Reservoir.
3. Eklund Creek flows north-east through the Wolverine Mountain Ranges into the west end of Manson Arm (Parsnip Reach) of Williston Reservoir.
4. Manson River flows north-east through the Wolverine Mountain Ranges into the south end of Manson Arm (Parsnip Reach) of Williston Reservoir.
5. Nation River flows north-east into the Nation Arm (Parsnip Reach) of Williston Reservoir.
6. Philip Creek is located in the Nechako Plateau and is a tributary of the Nation River Philip Creek flows north into the Nation River 30 km upstream from Williston Reservoir.

Netting Surveys

Gill netting in the embayments of Dunlevy and Carbon creeks was undertaken to identify: the presence of a kokanee population preparing to spawn in the creeks; if a sport fishery had been created in the sheltered embayment areas; and morphological characteristics of the stocked kokanee. An experimental monofilament gill net was set perpendicular to shoreline approximately one kilometre from the mouth of the streams. The net dimensions were 91.2 m long by 2.4 m wide. Cork buoys were attached to the top of the net to provide floatation. This arrangement enabled the net to hang as a curtain and fish from the surface to 2.4 m in depth. The net consisted of six panels of equal length, but different mesh sizes. The six "stretch" mesh sizes were 2.5 cm, 7.6 cm, 5.1 cm, 8.9 cm, 3.8 cm and 6.4 cm.

Gill netting was used at Philip Creek, a known location for kokanee, to determine if kokanee had deposited eggs, and to gather kokanee morphological data. A gill net 15.2 m long by 2.4 m deep with 2.5 cm "stretch" mesh was used to capture fish. The gill net was operated with the same techniques used for a beach seine.

Aerial Surveys

Aerial surveys, utilising two observers in a 206 Bell Jet Ranger helicopter, were conducted following Department of Fisheries and Oceans standards outlined by Robin Dickson (pers. comm.). The helicopter flew slightly above tree top level in an orientation which provided the observers full view of the stream channel and eliminated/minimized water surface glare. The following creeks and rivers were examined: Carbon, Dunlevy, Manson, Nation, Eklund and Philip. Aerial surveys were conducted on September 14, 29 and October 25.

Ground Surveys

Ground surveys were undertaken to identify kokanee presence in Dunlevy, Carbon, and Morfee creeks. These surveys were conducted primarily where road access was available.

In response to local resident reports of kokanee sightings, all creeks on the east side of the Parsnip Reach between Mackenzie and Finlay Bay were examined. All bridge crossing locations along the Parsnip West Forest Service Road were checked for kokanee presence within the creeks.

Fish Sampling

Fork length and weight data were collected from captured kokanee, bull trout, and rainbow trout. Fork lengths were measured on a measuring board to the nearest 1 mm. Fish weights were measured on a digital balance to an accuracy of 0.1 g or a hand held Normark digital balance accurate to 28 g. Ovary samples were measured on a digital balance to an accuracy of 0.1 g. Scale samples were collected from all three of these fish species for age determination. Other species captured were enumerated and released alive when possible.

The sexual development of each kokanee was categorised as either mature, ripe, partially spent, or spent. Mature kokanee had spawning coloration, but eggs still tight in the skeins or did not express milt when the abdomen was gently squeezed. Ripe kokanee were those fish which had loose eggs in the body cavity or expressed gametes when the abdomen was lightly squeezed. Partially spent fish had less than 100% and at least 10% of the milt or eggs retained when captured. Spent fish had less than 10% of the milt or eggs remaining. Where possible, eggs of unspawned mature/ripe females were first weighed then counted to determine fecundity. The gonadosomatic index (GSI) for female kokanee was calculated using the formula:

$$GSI = ((GW \div TW) \times 100), \text{ where}$$

GW = gonad weight (g), and TW = total body weight (g).

RESULTS

Netting Surveys

Netting yielded 135 kokanee (Appendix 1). A detailed analysis of fish species captured is presented only for kokanee. Individual data/morphology for all netted fish species is provided in tabular form for reference (Appendix I). All but three of the kokanee analysed were 3 + years of age. Three plus indicates the kokanee have had three full years of growth, and are currently in the fourth and final year of growth prior to spawning.

Carbon Creek Embayment (August 26, 27)

Eighty one kokanee were captured at Carbon Creek embayment; however, only 66 were sampled. The 15 other kokanee were released unharmed and not sampled. The average length and weight of kokanee captured in the embayment of Carbon Creek was 266 mm and 254 g (Table 2). Nets were set in Williston Reservoir within approximately one km of the stream mouth (Appendix III).

Table 2. Mean fork lengths and weights of kokanee captured at Carbon Creek embayment.

Sex	Sample Size	Mean Length (mm)	Range (mm)	Mean Weight (g)	Range (g)
Female	29	267	250 - 285	251	199 - 290
Male	37	265	247 - 302	257	208 - 341
Combined	66	266	247 - 302	254	199 - 341

Fecundity data was obtained from 29 female kokanee captured at Carbon Creek embayment (Table 3). The mean value for the parameter measured is presented, followed by the range of minimum and maximum values in brackets.

Table 3. Mean egg total, ovary weight, and gonadosomatic index.

Sample Size	Number of Eggs	Ovary Weight (g)	Gonadosomatic Index
29	452(301-551)	19.6(9.6-28.1)	7.8(3.7-9.7)

Dunlevy Creek Embayment (August 23, 24)

Twenty three kokanee were captured and sampled from Dunlevy Creek. The average length and weight of captured kokanee from the embayment of Dunlevy Creek was 270 mm and 237 g (Table 4). Netting locations were in Williston reservoir within one km of the stream mouth (Appendix III).

Table 4. Mean fork lengths and weights of kokanee captured at Dunlevy Creek embayment.

Sex	Sample Size	Length (mm)	Range (mm)	Weight (g)	Range (g)
Female	3	266	261 - 273	225	199 - 255
Male	20	271	237 - 299	239	199 - 284
Combined	23	270	237 - 299	237	199 - 284

Fecundity data was obtained from the three female kokanee captured at Dunlevy Creek (Table 5). The mean value for the parameter measured is presented, followed by the range of minimum and maximum values in brackets.

Table 5. Mean egg total, ovary weight and gonadosomatic index.

Sample Size	Egg Total	Ovary Weight (g)	Gonadosomatic Index
3	465 (427 - 501)	16.6 (11.4-22.8)	7.2 (5.7-8.9)

Philip Creek (October 1)

Thirty one kokanee were captured and sampled at Philip Creek. The mean length and weight of kokanee captured in Philip Creek was 272 mm and 200 g (Table 6). Netting was conducted at a bridge crossing site on Philip Creek (Appendix III). Only one female was sampled, egg count was 552, but no ovary weight was collected.

Table 6. Mean fork lengths and weights of kokanee captured at Philip Creek.

Sex	Sample Size	Length (mm)	Range (mm)	Weight (g)	Range (g)
Female	7	266	249 - 279	162	142 - 199
Male	24	274	250 - 292	210	160 - 312
Combined	31	272	249 - 292	200	142 - 312

All Netting Sites Combined

Kokanee data from all three sites has been summarised in tabular form to facilitate comparison (Table 7). It is important to note that although Philip Creek fish were slightly larger than the other fish, they did weigh less. This weight difference may be due to the kokanee being in a "run-down" condition and spawned out prior to sampling. The number of females sampled for egg total, ovary weight, and GSI for Carbon Creek were 29, three for Dunlevy Creek, and only one for Philip Creek.

Table 7. Mean values of kokanee data obtained at the three netting sites.

Location	Sample Size	Length (mm)	Weight (g)	Sex Ratio (m:f)	Egg Total (n)	Ovary Weight (g)	Gonadosomatic Index
Carbon Creek (Aug. 26,27)	66	266	254	1:0.78	452 (29)	19.6	7.8
Dunlevy Creek (Aug. 23,24)	24	270	237	1:0.14	465 (3)	16.6	7.2
Philip Creek (Oct. 1)	31	272	200	1:0.29	552 (1)		-
Combined (mean values)	121	(268)	(236)	(1:0.48)	(453)	(19.3)	(7.8)

A comparison of three kokanee stocks: stocked Williston Reservoir kokanee (1994), wild Finlay River stock (1991), and the Hill Creek Spawning Channel stock (1994) reveal slight variations (Table 8). All measurements and egg counts are mean values. The sample size of females for the egg totals, ovary weights, and GSI were 19 for the Finlay River, 33 for the Williston sample, and 152 for the Hill Creek sample.

Table 8. Comparison of three kokanee stocks.

Location	Sample Size	Length (mm)	Weight (g)	Egg Total ( )	Ovary Weight (g)	Gonadosomatic Index
Finlay River (wild stock)	56	286	302	424 (19)	22.1	7.3
Williston (hatchery stock)	121	268	236	453 (33)	19.3	7.8
Hill Creek (hatchery stock)	298	240		302 (152)		

External coloration of the Williston Reservoir and Finlay River kokanee stocks are quite different. Captured kokanee in the Williston Reservoir and kokanee from Hill Creek possess bright red bodies with an emerald green head (Plate 1). In contrast, kokanee from the Finlay River have a rusty reddish brown body and head (Plate 2).

Plate 1: Williston Reservoir stocked kokanee (Hill Creek source).

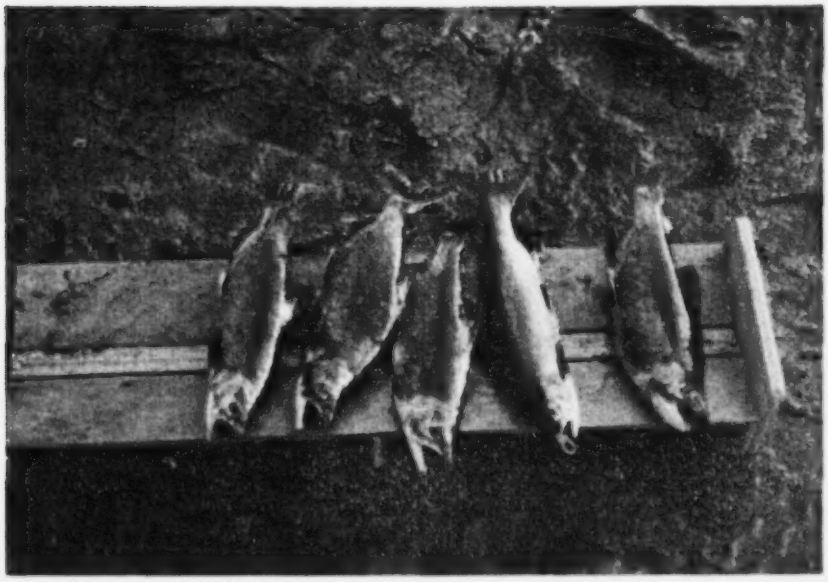

Plate 2: Finlay River wild stock kokanee.

Aerial Survey

Aerial surveys were conducted on September 14, 29, and October 25.

September 14

1. Manson River - Viewed from Manson Lakes to Williston Reservoir (60 km).
   No kokanee observed

September 29

1. Carbon Creek - Fish accessible length of creek surveyed (33 km).
   No kokanee observed
2. Dunlevy Creek - Viewed from waterfall barrier to Williston Reservoir (5 km).
   An estimated 300-400 kokanee were observed.
3. Manson River - Viewed from Manson Lakes to Williston Reservoir (60 km).
   No kokanee observed.
4. Nation River - Viewed from Chuchi Lake to Williston Reservoir (95 km).
   No kokanee observed.
5. Philip Creek - Viewed upstream 7 km from the confluence with Nation River (7 km).
   An estimated 2,000 kokanee were observed.

October 25

1. Eklund Creek - From Williston Reservoir viewed upstream approximately 15 km.
   No kokanee observed.
2. Manson River - Entire length of river surveyed (approximately 80 km).
   No kokanee observed.
3. Nation River - Viewed from Philip Creek to Williston Reservoir (approximately 25 km).
   No kokanee observed.
4. Philip Creek - Viewed upstream 2 km from confluence with Nation River (2 km).
   No kokanee observed.

The kokanee observed in Dunlevy Creek were located over a 2.0 km section beginning approximately 1.5 km upstream from the mouth. Two major concentrations of fish were observed at the base of beaver dams. The first dam appeared to make upstream kokanee passage strenuous. The second dam appeared to be a barrier to upstream kokanee migration. No height measurements were taken of the dams.

The kokanee observed in Philip Creek were concentrated at the base of a small waterfall, approximately 2 km upstream from the confluence with the Nation River. The waterfall was estimated at one metre in height. All kokanee were located in a 200 m section immediately downstream of the falls. Another five kilometres of stream were surveyed above the falls; however, no kokanee were observed.

Ground Surveys

Carbon Creek

A ground survey on October 18 failed to locate any kokanee in the Carbon Creek watershed. Investigated tributaries of Carbon Creek including Ten Mile Creek, Eleven Mile Creek, Indian Creek, and McAllister Creek. Carbon Creek was checked at the top of Reach 1, the Burn's Road bridge (km 1) in Reach 2, the bridge crossing on Johnson Creek Road (km 82.5) in Reach 5, and the bridge crossing on Johnson Creek Road (km 92) in Reach 6.

Dunlevy Creek

A ground survey on August 30 failed to locate any kokanee in Dunlevy Creek. Dunlevy Creek was walked from approximately 3 km upstream of the mouth to 1 km upstream of the mouth. Two large beaver dams, each approximately one metre in height, were breached during this survey.

East Parsnip Reach Tributaries

A ground survey on October 5, 6, and 7 failed to locate any kokanee in the tributaries of the East Parsnip Reach. All creeks crossed by the Parsnip West Forest Service Road from Mackenzie to Finlay Bay were examined for evidence of kokanee. Morfee Creek was examined 200 m on either side of the three bridge crossings. Mugaha Creek was examined 200 m upstream from the confluence with Morfee Creek.

Reported Sightings

1. Carbon Creek - a logger reported he saw six kokanee in Eleven Mile Creek at the base of the falls on September 1.
2. Carbon Creek - a Chetwynd Rod and Gun Club member reported a school of approximately 60 kokanee in Eleven Mile Creek at the base of the falls in early September.
3. Peace River - a B.C. Hydro employee reported a school of approximately 24 kokanee downstream of the Peace Canyon Dam during the last week of September.
4. Nation River - a Mackenzie Fish and Game Club member reported a very large school, (thousands) of kokanee, at the canyon section of Nation River in late September. The canyon section of Nation River is located approximately 1 km upstream of the confluence with Philip Creek.
5. East Parsnip Tributaries - Residents from Mackenzie observed kokanee in Morfee Creek in late September.
6. Schooler Creek - a Mackenzie resident caught kokanee near the stream mouth in the middle of September.

DISCUSSION

The 1994 kokanee spawning assessment failed to provide complete data to properly assess the kokanee stocking program of Williston Reservoir. This failure was due to a limited helicopter budget and the unknown timing of when these kokanee would enter the streams to spawn.

Aerial surveys were too few and spread out over too long a time frame to confidently determine escapement numbers. Since the timing of spawning was unknown prior to this study, helicopter flights had to be spread out over a two month time frame. Kokanee were spotted by helicopter in two of the four stocked systems: Dunlevy and Philip Creeks. No kokanee were observed in the Manson or Nation rivers. Concluding that kokanee did not return to these rivers would be premature.

Netting efforts produced kokanee in Carbon and Dunlevy embayments, and Philip Creek. The number of kokanee captured at Carbon and Dunlevy embayments indicate that a potential sport fishery has been created at these locations. The degree of utilisation by anglers has not been assessed. The gill netting undertaken at Philip Creek indicates that the kokanee are using this system for spawning.

No kokanee were observed by program staff during the ground surveys. Reports of sightings from area residents indicated kokanee were present in some of the Williston Reservoir tributaries. Since these reported sightings all occurred in September, it would appear that the peak spawning period occurred during this month in 1994.

An estimate of 2,000 kokanee were observed in Philip Creek. Spent male and female kokanee captured at Philip Creek indicated that egg deposition did occur. Estimates of total egg numbers released is not possible as accurate sex ratios were not obtained. The gill netting technique utilised biased selection towards males and their more pronounced teeth and jaw structures. Determining if a self sustaining population has been created in Philip Creek is not possible with the results obtained in the 1994 assessment.

Morphological comparisons of Finlay River (1990), Hill Creek (1990, 1994), and stocked Williston Reservoir (1994) adult kokanee indicate both genetic and environmental factors are present. The stocked Williston kokanee appear to spawn at the same time as Hill Creek stocks, but months earlier than the Finlay River kokanee. The Williston spawners have the same bright red body, green head coloration of the Hill Creek stocks, in contrast to the rusty reddish brown entire body colour of the Finlay River kokanee. The wild stock kokanee of Finlay River are the largest of the three stocks. The stocked kokanee of Williston Reservoir are larger than their parents (Hill Creek 1990), and their Hill Creek cohorts which returned to the spawning channel in 1994. Predator/prey relationships, inter and intra specific competition, productivity, etc. would account for the different size of Williston and Arrow Lake kokanee.

The Williston stocked kokanee, with three exceptions, were age 3+. This designation indicates the fish have had three full summer growth seasons, and are now in their fourth and final year of growth. One kokanee was aged at 2+ (jack), and two were aged at 4+. The Hill Creek and Williston stocked kokanee both returned to spawn at age 3+. The Finlay River kokanee were reported to be returning to spawn at age 3. This is discrepancy is a variance in nomenclature. The Finlay River kokanee were returning to spawn after four summer seasons of growth just as the introduced stocks were.

In 1993, ground and aerial surveys were conducted on Dunlevy Creek to locate any spawning kokanee. During early September to early November, the stream banks were walked weekly by members of the Hudson's Hope Rod and Gun Club and no kokanee were spotted. In September of 1994, kokanee were observed spawning in Dunlevy Creek. It appears the 1990 stocking of Dunlevy Creek was unsuccessful as no adults returned to this creek to spawn in 1993.

This study has identified late September as the probable spawning time for the Hill Creek kokanee stocked in Williston Reservoir. This information will be vital to future stock monitoring evaluations. A sport fishery appears to have been created. Whether or not a self sustaining population of kokanee has developed is unknown at this time. Proper assessment of the kokanee stocking program will require additional investigation concentrating at the locations and time periods identified by this study.

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APPENDIX I

(Kokanee stocking records)

Kokanee release sites, dates, numbers, and mean weights.
(Source: MOELP Release Records Database)

Location	Date	Number	Mean Weight
Carbon Creek	May 24, 1990	106,500	1.0
Carbon Creek	July 4, 1991	101,798	2.1
Carbon Creek	June 12, 1992	193,000	1.0
Carbon Creek	May 18, 1993	100,000	1.2
Carbon Creek	May 17, 1994	105,000	1.7
Dunlevy Creek	May 25, 1990	25,000	1.0
Dunlevy Creek	July 4, 1991	25,000	2.1
Dunlevy Creek	June 12, 1992	25,089	1.0
Dunlevy Creek	May 18, 1993	25,000	1.2
Dunlevy Creek	May 17, 1994	27,398	1.7
Manson River	May 23, 1990	225,000	1.0
Manson River	July 3, 1991	101,898	2.1
Manson River	June 11, 1992	72,375	1.0
Manson River	May 18, 1993	192,400	1.2
Manson River	May 17, 1994	206,198	1.5
Nation River	May 23, 1990	100,000	1.0
Nation River	July 3, 1991	25,000	2.1
Nation River	June 11, 1992	163,085	1.0
Nation River	May 18, 1993	72,000	1.2
Nation River	May 17, 1994	79,000	1.7

APPENDIX II

(Gill Net Data)

CARBON EMBAYMENT NETTING (NET SITE #1)

CREW: A. LANGSTON, R. ZEMLAK
SURFACE WATER TEMPERATURE = 16 C.
START SET AT 12:00 HRS, AUG. 26, 1994
END SET AT 15:30HRS,AUG.27,1994
FLOATING NET, FLOATS ATTACHED

EXPERIMENTAL GILL NET (6 PANELS / 91.4 m)
NET STRETCH SIZES (25 mm, 76 mm, 51 mm, 89 mm, 38 mm, 64 mm)
SHALLOW END = 2.4 m. (25 mm)
DEEP END = 5.4 m. (64 mm)
AVERAGE DEPTH = 5.5 m.

species	length(mm)	weight (g)	age (yrs)	sex	ovary wt (g)	egg total
KO	247	208	2 +	m-mature		
KO	250	199	3 +	f-mature	15.6	435
KO	250	212	3 +	f-mature	16.2	461
KO	250	216	3 +	m-mature		
KO	255	220	3 +	f-mature	19.9	488
KO	257	238	? 3 +	m-mature		
KO	258	228	3 +	f-mature	19.9	420
KO	259	238	3 +	f-mature	15.9	480
KO	260	236	3 +	f-mature	20.6	444
KO	260	238	3 +	m-mature		
KO	260	244	3 +	f-mature	18.9	497
KO	260	247	3 +	m-mature		
KO	260	256	3 +	m-mature		
KO	261	242	3 +	m-mature		
KO	261	245	3 +	m-mature		
KO	262	218	3 +	m-mature		
KO	262	234	3 +	f-mature	15.6	488
KO	262	264	3 +	m-mature		
KO	263	245	3 +	m-mature		
KO	264	250	3 +	m-mature		
KO	265	232	3 +	m-mature		
KO	265	264	3 +	f-mature	16.3	510
KO	266	256	3 +	f-mature	23.6	509
KO	266	257	3 +	m-mature		
KO	266	266	3 +	f-mature	18.2	no count
KO	267	253	3 +	f-mature	18.8	523
KO	267	261	3 +	m-mature		
KO	270	274	3 +	m-mature		

* 46 KOKANEE CAPTURED, 38 KOKANEE SAMPLED, 8 KOKANEE RELEASED
* 20 RAINBOW TROUT CAPTURED, 16 RAINBOW TROUT SAMPLED, 4 (WILD) RAINBOW TROUT RELEASED
* 2 BULL TROUT CAPTURED, 2 BULL TROUT RELEASED

species	length (mm)	weight (g)	age (yrs)	sex	ovary wt (g)	egg total
KO	271	280	3 +	f-mature	18.2	496
KO	272	282	3 +	m-mature		
KO	272	283	3 +	m-mature		
KO	273	254	3 +	f-mature	21	421
KO	274	268	3 +	f-mature	19.4	428
KO	275	287	3 +	f-mature	21.2	524
KO	276	264	3 +	f-mature	25.3	551
KO	277	275	3 +	f-mature	23.3	502
KO	281	274	3 +	f-mature	22	532
KO	281	290	3 +	m-mature		
RB	220	138	2 +	f		
RB	255	180	3 +	m		
RB	259	201	3 +	f		
RB	271	243	3 +	m		
RB	276	233	3 +	f		
RB	277	252	3 +	m		
RB	277	254	3 +	f		
RB	280	236	3 +	m		
RB	280	240	3 +	?		
RB	290	246	3 +	f		
RB	299	276	4 +	?		
RB	302	284	4 +	m		
RB	305	312	4 +	f		
RB	307	312	4 +	f		
RB	318	312	3 + /4 +	f		
RB	352	482	4 +	m		
DV	250	148	4 +	?		
DV	277	171	5 +	?		

* 196 PEAMOUTH CHUB CAPTURED
* 22 WHITEFISH CAPTURED
* 2 NORTHERN SQUAWFISH CAPTURED

CARBON EMBAYMENT NETTING (NET SITE #2)

CREW: A. LANGSTON, R. ZEMLAK
SURFACE WATER TEMPERATURE = 16 C.
START SET AT 12:30 HRS., AUG. 26, 1994
END SET AT 12:30 HRS., AUG. 27, 1994
FLOATING NET, FLOATS ATTACHED

species	length (mm)	weight (g)	age (yrs)	sex	ovary wt (g)	egg total
KO	255	234	3 +	f-mature	18.3	493
KO	258	237	3 +	m-mature		
KO	259	246	3 +	m-mature		
KO	259	247	? 3 +	m-mature		
KO	259	266	3 +	m-mature		
KO	260	237	3 +	m-mature		
KO	260	250	3 +	m-mature		
KO	261	248	3 +	m-mature		
KO	261	261	3 +	m-mature		
KO	262	264	3 +	m-mature		
KO	263	249	3 +	m-mature		
KO	264	256	3 +	m-mature		
KO	264	257	3 +	m-mature		
KO	265	258	3 +	f-mature	9.6	301
KO	265	263	?	m-mature		
KO	266	249	3 +	f-mature	23.1	501
KO	266	253	3 +	f-mature	23.8	496
KO	267	224	3 +	f-mature	17.6	426
KO	267	265	3 +	m-mature		
KO	269	252	3 +	f-mature	18.1	468
KO	273	245	3 +	f-mature	19.2	402
KO	274	291	3 +	m-mature		
KO	275	260	3 +	f-mature	22.5	497
KO	275	276	?	m-mature		

* 35 KOKANEE CAPTURED, 28 KOKANEE SAMPLED, 7 KOKANEE RELEASED
* 28 RAINBOW TROUT CAPTURED, 21 RAINBOW TROUT SAMPLED, 7 RAINBOW TROUT RELEASED
* 121 PEAMOUTH CHUB CAPTURED
* 71 WHITEFISH CAPTURED

EXPERIMENTAL GILL NET (6 PANELS/ 91.4 m)
NET STRETCH SIZES (25 mm, 76 mm, 51 mm, 89 mm, 38 mm, 64 mm)
SHALLOW END = 1.8 m. (25 mm)
DEEP END = 5.2 m. (64 mm)
AVERAGE DEPTH = 5.0 m.

species	length (mm)	weight (g)	age (yrs)	sex	ovary wt (g)	egg total
KO	276	254	3 +	f-mature	17.7	317
KO	277	292	?	m-mature		
KO	285	290	4 +	f-mature	28.1	484
KO	302	341	4 +	m-mature		
RB	278	275	3 +	f		
RB	318	360	4 +	m		
RB	309	340	3 +	f		
RB	308	332	3 +	f		
RB	323	431	4 +	f		
RB	295	286	3 +	f		
RB	291	279	?	f		
RB	240	193	3 +	f		
RB	279	259	3 +	f		
RB	250	203	3 +	f		
RB	296	289	3 +	f		
RB	303	334	4 +	f		
RB	269	224	3 +			
RB	272	244	3 +	m		
RB	283	260	3 +	m		
RB	311	306	4 +	m		
RB	254	173	3 +	m		
RB	259	196	3 +	m		
RB	239	163	3 +	m		
RB	301	279	3 +	f		
RB	314	379	4 +	m		

* 12 REDSIDE SHINERS CAPTURED
* 3 LARGESCALE SUCKERS CAPTURED
* 2 NORTHERN SQUAWFISH CAPTURED
* 1 SCULPIN CAPTURED

DUNLEVY EMBAYMENT NETTING (NET SITE #1, SET #1)

CREW: A. LANGSTON, R. ZEMLAK
SURFACE WATER TEMPERATURE = 17 C.
START SET AT 11:00 HRS., AUG. 23, 1994
END SET AT 13:10 HRS., AUG.23, 1994
FLOATING NET, FLOATS ATTACHED
EXPERIMENTAL GILL NET (6 PANELS, 91.4 m)
NET STRETCH SIZES (25 mm, 76 mm, 51 mm, 89 mm, 38 mm, 64 mm)
SHALLOW END = 2.0 m. (25 mm)
DEEP END = 7.3 m. (64 mm)
AVERAGE DEPTH = 5.0 m.
AT 13:10, NET CHECKED, FEW FISH
AT 14:30, NET PULLED, FISH PICKED, RESET AT 15:30 HRS.

species	length (mm)	weight (g)	age (yrs)	sex	ovary wt (g)	egg total
KO	263	222	3 +	f-mature	15.6	427
KO	272	253	? 3 +	m-mature		
KO	280	275	3 +	m-mature		

* 3 KOKANEE CAPTURED, 3 KOKANEE SAMPLED
* 4 LAKE WHITEFISH CAPTURED
* 13 PEAMOUTH CHUB CAPTURED

DUNLEVY EMBAYMENT NETTING (NET SITE #1, SET #2)

START SET AT 15:30 HRS., AUG. 23,1994
END SET AT 10:00 HRS., AUG. 24, 1994
SURFACE WATER TEMPERATURE = 17 C.

species	length (mm)	weight (g)	age (yrs)	sex	ovary wt (g)	egg total
KO	237	199	3 +	m-mature		
KO	256	199	3 +	m-mature		
KO	261	199	3 +	f-mature	11.4	501
KO	263	227	3 +	m-mature		
KO	264	199	3 +	m-mature		
KO	265	199	3 +	m-mature		
KO	265	227	3 +	m-mature		
KO	272	255	?	m-mature		
KO	273	255	?	f-mature	22.8	467
KO	275	255	?	m-mature		
KO	275	255	?	m-mature		
KO	276	284	3 +	m-mature		
KO	277	255	?	m-mature		
KO	280	227	?	m-mature		
KO	286	255	?	m-mature		
KO	299	312	?	m-mature		
DV	276	199	5 +	f		
DV	307	255	6 +	f		
DV	312	255	6 +	f		

* 16 KOKANEE CAPTURED, 16 KOKANEE SAMPLED
* 3 BULL TROUT CAPTURED, 3 BULL TROUT SAMPLED
* 15 WHITEFISH CAPTURED
* 12 REDSIDE SHINERS CAPTURED
* 102 PEAMOUTH CHUB CAPTURED
* 7 NORTHERN SQUAWFISH CAPTURED

DUNLEVY EMBAYMENT NETTING (NET SITE #2, SET #1)

CREW: A. LANGSTON, R. ZEMLAK
SURFACE WATER TEMPERATURE = 17 C.
START SET AT 12:30 HRS., AUG. 23, 1994
END SET AT 14:10 HRS., AUG. 23, 1994
FLOATING NET, FLOATS ATTACHED
EXPERIMENTAL GILL NET (6 PANELS, 91.4 m)
NET STRETCH SIZES (25 mm, 76 mm, 51 mm, 89 mm, 38 mm, 64 mm)
SHALLOW END = 2.0 m. (25 mm)
DEEP END = 7.4 m. (64 mm)
AVERAGE DEPTH = 5.0 m.
AT 14:10, NET CHECKED, FEW FISH
AT 15:15, NET PULLED, FISH PICKED, RESET AT 16:00

species	length (mm)	weight (g)	age (yrs)	sex
KO	263	253	? 3 +	m-mature

* 1 KOKANEE CAPTURED, 1 KOKANEE SAMPLED
* 2 NORTHERN SQUAWFISH CAPTURED
* 10 PEAMOUTH CHUB CAPTURED

DUNLEVY EMBAYMENT NETTING (NET SITE #2, SET #2)

START SET AT 16:00 HRS., AUG. 23, 1994
END SET AT 14:00 HRS., AUG. 24, 1994
3 +

species	length (mm)	weight (g)	age (yrs)	sex	
KO	254	199	3 +	m-mature	
KO	270	227	3 +	m-mature	
KO	280	227	3 +	m-mature	
DV	257	142	5 +	f	
RB	290	142	3 +	f-mature	* adipose clip, no right pectoral

* 3 KOKANEE CAPTURED, 3 KOKANEE SAMPLED
* 1 BULL TROUT CAPTURED, 1 BULL TROUT SAMPLED
* 1 RAINBOW TROUT CAPTURED, 1 RAINBOW TROUT SAMPLED
* 55 PEAMOUTH CHUB CAPTURED
* 12 WHITEFISH CAPTURED
* 12 NORTHERN SQUAWFISH CAPTURED
* 3 LARGESCALE SUCKERS CAPTURED

PHILIP CREEK NETTING

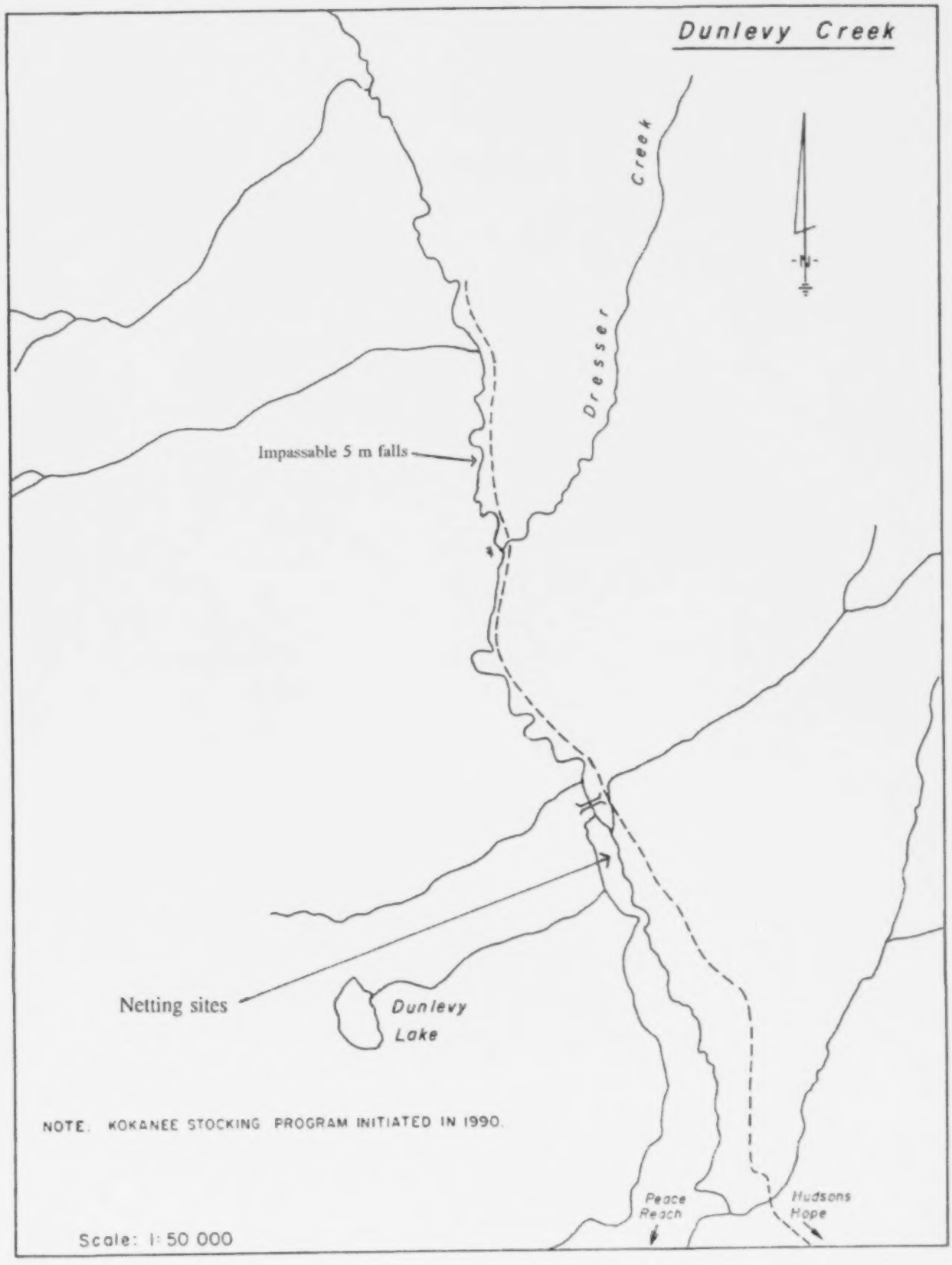
OCTOBER 1, 1994
CREW: BRIAN BLACKMAN
GILL NET (1 PANEL /15.2)
STRETCH MESH SIZE OF 25 mm
AVERAGE DEPTH = 1.0 m

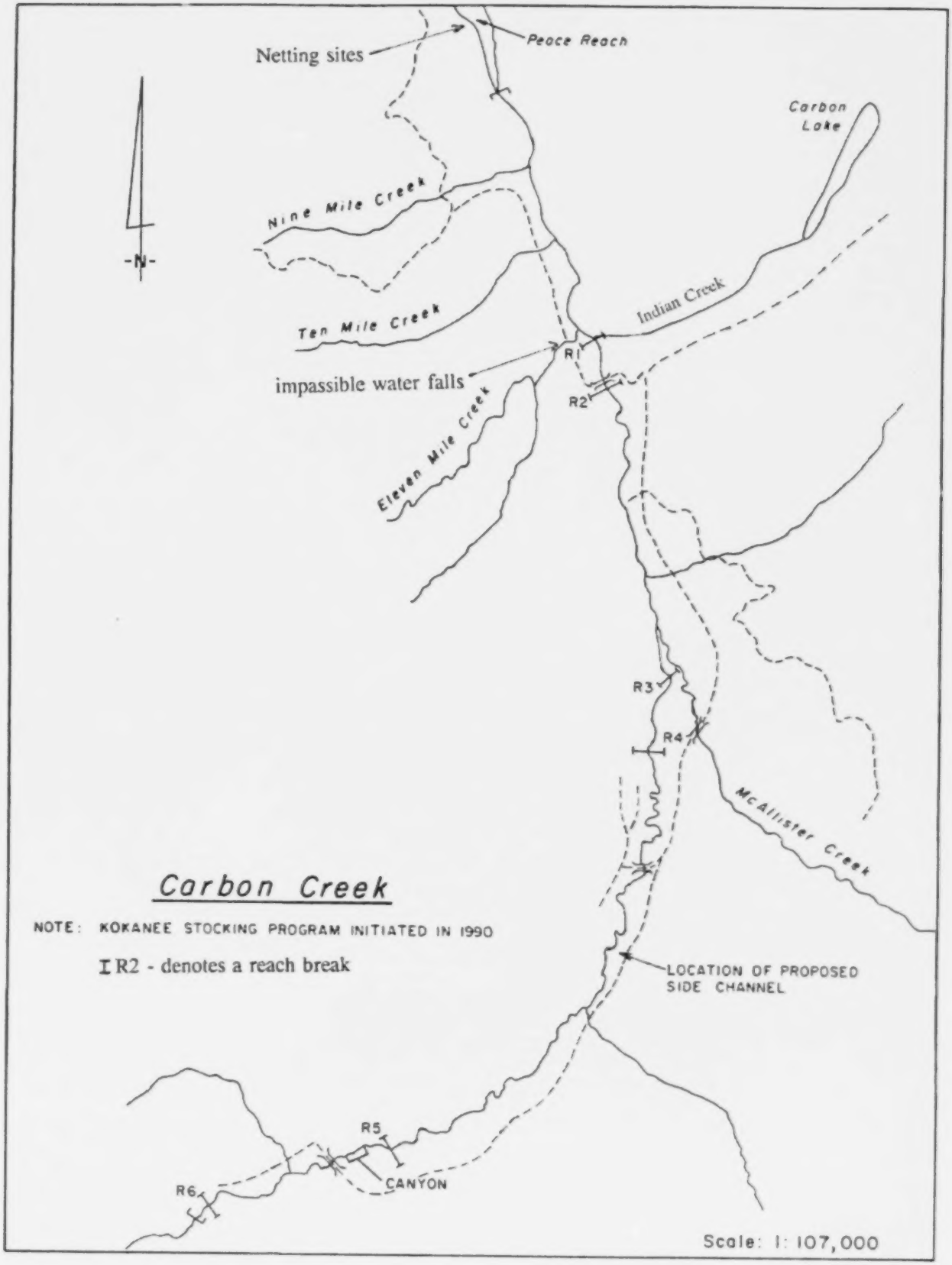
species	length (mm)	weight (g)	age (yrs)	sex	ovary wt (g)	egg total
KO	249	144	3 +	f-spent		
KO	250	170	3 +	m		
KO	259	150	3 +	f-spent		
KO	260	170	9	m		
KO	262	170	?	m-ripe		
KO	264	142	3 +	f-spent		
KO	265	199	3 +	m-ripe		
KO	267	255	3 +	m-ripe		
KO	268	160	3 +	m-ripe		
KO	268	170	? 3 +	f-spent		
KO	269	150	? 3 +	f-spent		
KO	270	170	3 +	m		
KO	270	227	3 +	m		
KO	271	170	?	m		
KO	271	170	? 3 +	m-ripe		
KO	271	227	3 +	m-ripe		
KO	273	199	3 +	m-ripe		
KO	273	215	3 +	m-ripe		
KO	275	180	3 +	f-p.spent		
KO	275	210	3 +	m-ripe		
KO	278	210	3 +	m		
KO	279	199	3 +	f-ripe		552
KO	279	199	3 +	m		
KO	279	227	3 +	m		
KO	279	255	3 +	m-ripe		
KO	280	199	4 +	m-ripe		
KO	280	220	3 +	m-ripe		
KO	281	227	3 +	m		
KO	285	260	3 +	m-ripe		
KO	290	312	3 +	m		
KO	292	227	3 +	m-ripe		

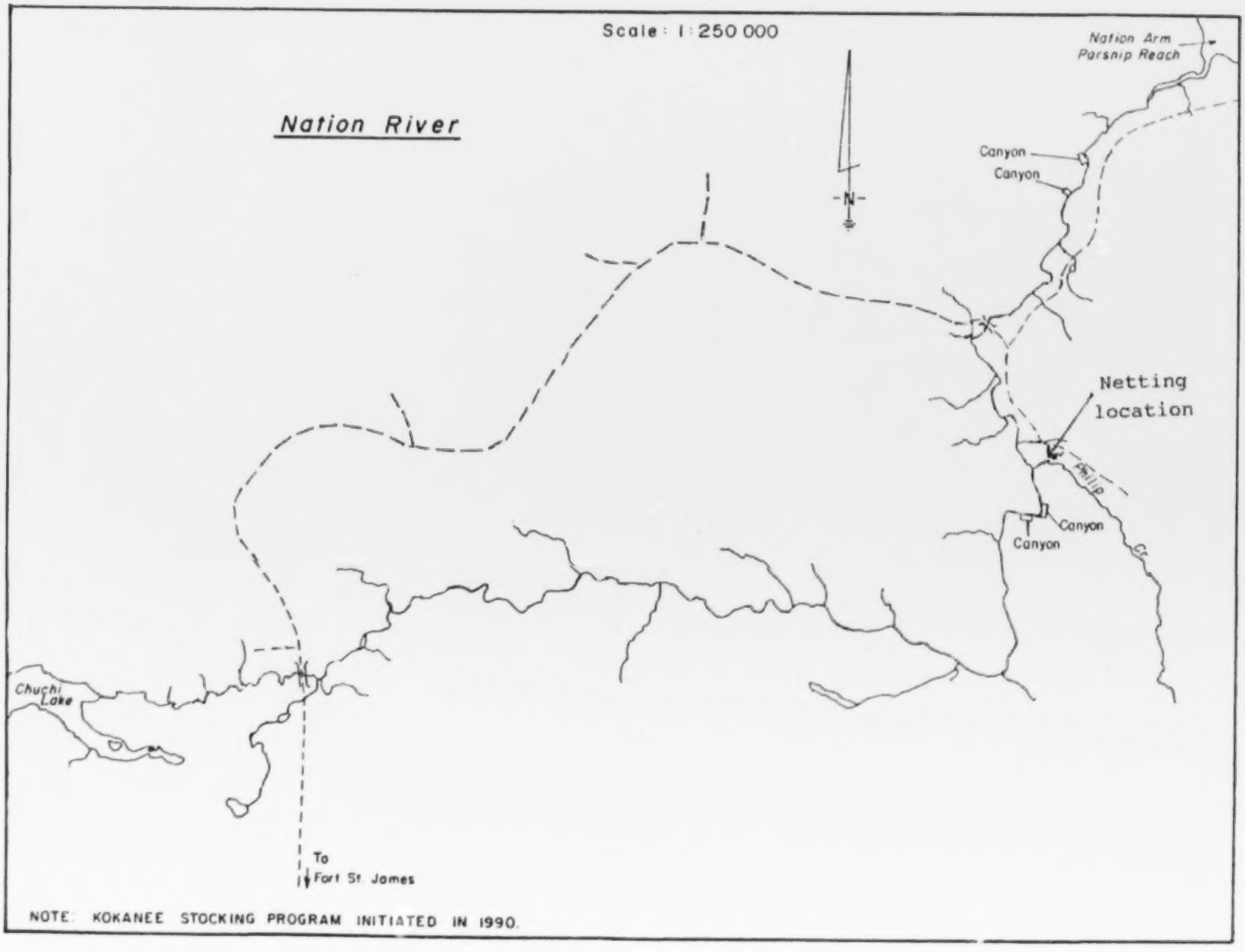
* 31 KOKANEE CAPTURED, 31 KOKANEE SAMPLED

APPENDIX III

(Net Site Locations)


Dunlevy Creek
Dresser Creek
N
Impassable 5 m falls
Netting sites
Dunlevy Lake
NOTE. KOKANEE STOCKING PROGRAM INITIATED IN 1990.
Peace Reach
Hudsons Hope
Scale: 1: 50 000


Netting sites
Peace Reach
Carbon Lake
Nine Mile Creek
N
Ten Mile Creek
Indian Creek
R1
impassible water falls
R2
Eleven Mile Creek
R3
R4
McAllister Creek
Carbon Creek
NOTE: KOKANEE STOCKING PROGRAM INITIATED IN 1990
I R2 - denotes a reach break
LOCATION OF PROPOSED SIDE CHANNEL
R5
CANYON
R6
Scale: 1: 107,000


Scale: 1:250 000
Nation River
N
Nation Arm
Parsnip Reach
Canyon
Canyon
Netting
location
Philip Cr
Canyon
Canyon
Chuchi
Lake
To
Fort St James
NOTE: KOKANEE STOCKING PROGRAM INITIATED IN 1990.